गोंय विद्यापीठ
ताळगांव पठार,
गोंय – ४०३ २०६
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(Accredited by NAAC)

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GU/Acad –PG/BoS -NEP Engg. /2024-25/742 Date: 29.01.2025

CIRCULAR

Ref. No.: GU/Acad –PG/BoS -NEP Engg. /2024/635 dated 07.11.2024

In supersession to the above referred Circular, the Syllabus of Semester II of the **Master of Engineering (Information Technology and Engineering)** Programme approved by the Academic Council in its meeting held on 06th December 2024 is attached herewith. The syllabus of Semester I approved earlier by the Academic Council in its meeting held on 22nd August 2024 is also attached

The Dean, Faculty of Engineering and Principals of affiliated Colleges offering the **Master of Engineering (Information Technology and Engineering)** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2025.01.29 12:44:38 +05'30'

(Ashwin V. Lawande)
Deputy Registrar – Academic

To,

1. The Dean, Faculty of Engineering, Goa University.
2. The Principals of affiliated Engineering Colleges.

Copy to,

1. The Director, Directorate of Technical Education, Govt. of Goa
2. The Chairperson, BoS in Information Technology Engineering.
3. The Controller of Examinations, Goa University.
4. The Assistant Registrar Examinations (Prof.), Goa University.
5. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

MASTER OF ENGINEERING (INFORMATION TECHNOLOGY AND ENGINEERING)
RC 2024-25

TWO YEAR PROGRAMME STRUCTURE						
SEMESTER I						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	ITH-500	Constrained Networks	3	0	0	3
2	ITH-501	Constrained Networks lab	0	0	1	1
3	ITH-502	Intelligent and Learning Systems	3	0	0	3
4	ITH-503	Intelligent Systems Lab	0	0	1	1
5	ITH-504	Mathematics for Information Science	3	1	0	4
Programme Specific Elective (PSE) Courses						
6	ITH-531	Mobile and Pervasive Computing	4	0	0	4
OR						
7	ITH-532	Natural Language Processing	4	0	0	4
Research Specific Elective (RSE) Courses						
8	REC-561	Engineering Research and Publication	3	1	0	4
OR						
9	REC-562	Literature Review and Technical Writing for Engineers	3	1	0	4
		TOTAL	**16**	**2**	**2**	**20**
SEMESTER II						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	ITH-505	Data Analytics and Visualization	3	0	0	3
2	ITH-506	Data Analytics Lab	0	0	1	1
3	ITH-507	Information Assurance and Security	3	0	0	3
4	ITH-508	Information Assurance and Security Lab	0	0	1	1
5	ITH-509	Algorithm Design and Optimization	3	0	0	3
6	ITH-510	Algorithm Design and Optimization Lab	0	0	1	1
Programme Specific Elective (PSE) Courses						
7	ITH-533	Smart Robots	3	0	0	3
8	ITH-534	Smart Robots Lab	0	0	1	1
OR						
9	ITH-535	Grid Computing	3	0	0	3
10	ITH-536	Grid Computing Lab	0	0	1	1
Research Specific Elective (RSE) Courses						
11	REC-563	Statistics and Data Analysis for Engineering Research	2	0	0	2
12	REC-564	Statistics and Data Analysis Lab	0	0	2	2
OR						
13	REC-565	Statistical Techniques for Engineering Research	2	0	0	2
14	REC-566	Probability and Statistical Analysis Lab	0	0	2	2
		Total	**14**	**0**	**6**	**20**

THREE YEAR PROGRAMME STRUCTURE						
SEMESTER I						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
Programme Specific Core (PSC) Courses						
1	ITH-500	Constrained Networks	3	0	0	3
2	ITH-501	Constrained Networks lab	0	0	1	1
Programme Specific Elective (PSE) Courses						
3	ITH-531	Mobile and Pervasive Computing	4	0	0	4
OR						
4	ITH-532	Natural Language Processing	4	0	0	4
Research Specific Elective (RSE) Courses						
5	REC-561	Engineering Research & Publications	3	1	0	4
OR						
6	REC-562	Literature Review & Technical Writing for Engineers	3	1	0	4
		TOTAL	**10**	**1**	**1**	**12**
SEMESTER II						
Programme Specific Core (PSC) Courses						
Sr. No.	**Course Code**	**Title of the Course**	**L**	**T**	**P**	**Credits**
1	ITH-505	Data Analytics and Visualizations	3	0	0	3
2	ITH-506	Data Analytics Lab	0	0	1	1
Programme Specific Elective (PSE) Courses						
3	ITH-533	Smart Robots	3	0	0	3
4	ITH-534	Smart Robots Lab	0	0	1	1
OR						
5	ITH-535	Grid Computing	3	0	0	3
6	ITH-536	Grid Computing Lab	0	0	1	1
Research Specific Elective (RSE) Courses						
7	REC-563	Statistics and Data Analysis for Engineering Research	2	0	0	2
8	REC-564	Statistics and Data Analysis Lab	0	0	2	2
OR						
9	REC-565	Statistical Techniques for Engineering Research	2	0	0	2
10	REC-566	Probability and Statistical Analysis Lab	0	0	2	2
		Total	**8**	**0**	**4**	**12**

SEMESTER I

Name of the Programme	**: M.E in Information Technology Engineering**
Course code	**: ITH-500**
Title of the course	**: Constrained Networks**
Number of Credits	**: 3 (3L)**
Effective from AY	**: 2024-25**

Pre-requisites for the Course:	Basic knowledge of Networking	
Course Objectives:	This course will enable students to: 1. Understand how networks and Internet of things helps in solving real life problems. 2. Gain knowledge on various IoT technologies. 3. Understand the operational issues in the constrained environment.	
Contents:	**Topics**	**No. of Hours**
Unit 1	**Internet/Web and Networking**: Reference models- The OSI Reference Model- the TCP/IP Reference Model, IP Addressing, Network Topologies, Sub-netting, Different networks, Connection of networks, Tunneling, Packet Fragmentation, Web Servers, Cloud Computing basics.	**10**
Unit 2	**Application Layer:** DNS—The Domain Name System, The DNS Name Space, Domain Resource Records, Name Servers. **Electronic MAIL:** Architecture and Services, The User Agent, Message Formats, Message Transfer, Final Delivery. **World Wide Web:** Architectural Overview. **Streaming Audio and Video:** Streaming Stored Media, Streaming Live Media. Content Delivery.	**10**
Unit 3	Evolution of IoT, Web 3.0 view of IoT, Definition and characteristics of IoT, IoT Enabling Technologies, IoT Architecture, Fog, Edge and Cloud in IoT, Functional blocks of a IoT ecosystem, Sensors, Actuators, Smart Objects and Connecting Smart Objects, IoT levels and deployment templates, IoT applications. **Overview of IoT supported Hardware platforms**: Raspberry pi and Arduino.	**10**
Unit 4	**IoT Access Technologies:** Constrained Nodes and Constrained Networks – **Optimizing IP for IoT:** 6LoWPAN, Routing over Low Power and Lossy Networks – Application Transport Methods: Supervisory Control and Data Acquisition -Application Layer Protocols: CoAP and MQTT- Data aggregation & dissemination.	**15**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books:** 1. Andrew S. Tanenbaum, David J. Wetherall, “Computer Networks”, Pearson Education, 5th Edition, 2014. 2. Vijay Madisetti, Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, 2015. 3. W. Richard Stevens, “Unix Network Programming”, Prentice	

	Hall/Pearson Education, 3rd Edition, 2009. **Reference Books:** 1. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, 1/e, 2013.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the conceptual and practical aspects of operating in constrained environments. CO 2. Apply the knowledge gained in understanding networks and IoT. CO 3. Analyse scenarios to design applications. CO 4. Create solutions for real life scenarios using Constrained devices.

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Name of the Programme : **M.E in Information Technology Engineering**
Course code : **ITH-501**
Title of the course : **Constrained Networks lab**
Number of Credits : **1 (1P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basics of Networking and programming language.	
Course Objectives:	This course will enable students to: 1. Understand how networks are created 2. Gain knowledge on implementing IoT applications 3. Understand the operational issues in the constrained environment.	
Contents:	**Topics**	**No. of Hours**
	1. Implementation of Subnetting. 2. Audio Streaming of data 3. Video Streaming of data 4. Designing IoT applications 5. Implementing IoT protocols (CoAP). 6. Implementing IoT protocols (MQTT). 7. Application with MQTT 8. Mini project on IoT 9. Using the cloud 10. Data storage on Cloud	**30**
Pedagogy:	Constructive, Collaborative and Inquiry Based Learning	
Instructions:	Minimum 8 experiments to be performed from above list.	
References/ Readings:	**Text Books:** 1. Andrew S. Tanenbaum, David J. Wetherall, “Computer Networks”, Pearson Education, 5th Edition, 2014. 2. Vijay Madisetti, Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st edition, 2015. 3. W. Richard Stevens, “Unix Network Programming”, Prentice Hall/Pearson Education, 3rd Edition, 2009. **Reference Books:** 1. Adrian McEwen, Hakim Cassimally, “Designing the Internet of Things”, 1/e, 2013.	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the conceptual and practical aspects of designing networks CO 2. Apply the knowledge gained in understanding networks and IoT. CO 3. Analyse scenarios to design IoT applications. CO 4. Create solutions for real life scenarios using Constrained devices.	

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Name of the Programme : M.E in Information Technology Engineering
Course code : ITH-502
Title of the course : Intelligent and learning systems
Number of Credits : 3 (3L)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic concepts of Artificial Intelligence.	
Course Objectives:	This course will enable students to: 1. Understand principles of Artificial intelligence toward problem solving, inference, perception, and learning. 2. Investigate applications of AI techniques in intelligent agents, artificial neural networks and other machine learning models. 3. Experiment with a machine learning model for simulation and analysis. 4. Explore the current scope, potential, limitations, and implications of intelligent systems.	
Contents:	**Topics**	**No. of Hours**
Unit 1	**Introduction:** Foundation of AI, Agents and environments, the nature of the Environment, Problem solving Agents, Problem Formulation, Search Strategies. **Knowledge representation:** Knowledge Engineering, Representing structure in frames, Rules and data, Object-oriented systems, Natural language Semantics, Levels of representation.	**10**
Unit 2	**Learning:** Learning from observations, Inductive Learning, Concept Learning, Version Spaces and Candidate Eliminations, Inductive bias, Decision Tree learning. **Instant based learning**: Locally weighted Regression – Radial Bases Functions, Case Based Learning	**10**
Unit 3	**Advanced learning:** Analytical Learning (Perfect Domain Theories – Explanation Base Learning (FOCL Algorithm), Reinforcement Learning, Q-Learning, Temporal Difference Learning. **Learning in Neural network:** Neural Network Representation, Problems Perceptron, Multilayer Networks and Back Propagation Algorithms.	**15**
Unit 4	**Introduction to Robotics:** Tasks, parts, effectors, Sensors, Architectures, Configuration spaces, Navigation and motion planning, Introduction to AI based programming Tools.	**10**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books:** 1. S. Sridhar and M. Vijayalakshmi, "Machine learning", 1st Edition, 2021, ISBN:978-0190127275. 2. S. R. Deb, "Robotics Technology and flexible automation", Tata McGraw-Hill Education 2nd Edition ,2010. 3. Stuart Russell, Peter Norvig, "Artificial Intelligence: A Modern	

	Approach", Pearson Education, 3rd Edition, 2015. **Reference Books:** 1. Ronald J. Brachman, Hector J. Levesque, "Knowledge Representation and Reasoning", Elsevier, 1st edition ,2004. 2. Stephen Marsland, "Machine Learning: An Algorithmic Perspective", Taylor & Francis, 2nd edition, 2014. 3. Tom M. Mitchell, "Machine Learning", McGraw-Hill Science, 1st edition, 2017.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the concept of learning and its significance to the design of intelligence machines. CO 2. Analyse the range of machine learning algorithms along with their strengths and weaknesses. CO 3. Design various machine learning algorithms for real time applications. CO 4. Implement the learning models to various language, speech, vision applications related to society.

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Name of the Programme : **M.E in Information Technology Engineering**
Course Code : **ITH-503**
Title of the course : **Intelligent Systems Lab**
Number of Credits : **1 (1P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of Artificial Intelligence and programming language	
Course Objectives:	This course will enable students to: 1. Understand principles of Artificial intelligence toward problem solving, inference, perception, and learning. 2. Investigate applications of AI techniques in intelligent agents, artificial neural networks and other machine learning models. 3. Experiment with a machine learning model for simulation and analysis. 4. Explore the current scope, potential, limitations, and implications of intelligent systems.	
Contents:	**Topics**	**No. of Hours**
	1. Implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples. 2. Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample. 3. Implement the non-parametric Locally Weighted Regression algorithm in order to fit data points. 4. Implement Q learning algorithm for an appropriate data set. 5. Implement FOCL algorithm for an appropriate data set 6. Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets. 7. Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. 8. Introduction to basic robotic programming using visual ROS IDE 9. Robotic programming using visual ROS IDE 10. Write a program to construct a Bayesian network considering stock market data	**30**
Pedagogy:	Constructive, Collaborative and Inquiry Based Learning	
Instructions:	Minimum 8 experiments to be performed from above list.	
References/ Readings:	**Text Books:** 1. S. Sridhar and M. Vijayalakshmi, “Machine learning”, 1^{st} Edition, 2021, ISBN:978-0190127275. 2. S.R. Deb, “Robotics Technology and flexible automation”, 2^{nd} Edition,	

	2010, Tata McGraw-Hill Education. 3. Stuart Russell, Peter Norvig, “Artificial Intelligence: A Modern Approach”, Pearson Education, 3rd Edition, 2015. **Reference Books:** 1. Ronald J. Brachman, Hector J. Levesque, “Knowledge Representation and Reasoning”, Elsevier, 1st edition, 2004. 2. Stephen Marsland, Taylor & Francis, “Machine Learning: An Algorithmic Perspective”, 2nd edition, 2014. 3. Tom M. Mitchell, “Machine Learning”, McGraw-Hill Science, 1st Edition ,2017.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Understand the implementation procedures for the machine learning algorithms CO 2. Design programs for various Learning algorithms. CO 3. Apply appropriate data sets to the Machine Learning algorithms CO 4. Identify and apply Machine Learning algorithms to solve real world problem.

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Name of the Programme : **M.E in Information Technology Engineering**
Course code : **ITH-504**
Title of the course : **Mathematics for Information Science**
Number of Credits : **4 (3L+1T)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Fundamentals of mathematics.	
Course Objectives:	This course will enable students to: 1. Understand fundamental mathematical concepts used in computer science 2. Gain knowledge of Mathematics and linear Algebra in solving engineering related problems 3. Model Engineering problems with the concepts and techniques of Mathematics	
Contents:	**Topics**	**No. of Hours**
Unit 1	**Propositional Calculus:** propositions and connectives, syntax, Semantics – truth assignments and truth tables, validity and satisfiability, tautology, Adequate set of connectives, Equivalence and normal forms, Natural deduction system and axiom system.	**11+3T**
Unit 2	**Techniques for proving theorems:** Direct Proof, Proof by Contrapositive, Proof by exhausting cases and proof by contradiction, Principle of mathematical induction, Principle of complete induction. Recursive definitions, function of sequences calculating coefficient of generating function, solving recurrence relation by substitution and generating functions Solution methods for linear, first-order recurrence relations with constant coefficient, characteristic roots, Generating functions.	**12+4T**
Unit 3	**Algebraic Structures:** Groups and subgroups, homomorphism theorems, cosets and normal subgroups, Lagrange's theorem, Rings and Fields (Definition and examples only)	**10+4T**
Unit 4	**Linear Algebra:** Vector Spaces, Linear Independence, Basis and Rank, Linear Mappings. Norms, Inner Products, Lengths and Distances, Angles and Orthogonality, Orthonormal Basis, Orthogonal Complement, Inner Product of Functions.	**12+4T**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books:** 1. Hoffman, K. and Kunze, R., "Linear Algebra", Prentice-Hall, 2nd Edition 2. Kenneth H. Rosen, "Discrete Mathematics and its Applications", McGraw Hill Inc, 7/e, 2011 **Reference Books:** 1. Bernard Kolman, Robert C Busby, Sharon Kutler Ross, "Discrete Mathematical Structures", Prentice-Hall India Private Limited,2/e, 1996. 2. E. Mendelsohn, "Introduction to Mathematical Logic", Van-Nostrand,	

	London, 2nd ed. 1979. 3. J. P. Tremblay, R. Manohar, "Discrete Mathematical Structures with Application to Computer Science", Tata McGraw Hill, 1st Edition, 2000. 4. J. Truss, "Discrete Mathematics for Computer Scientists", Addison Wesley, 2/e, 1999.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the fundamental mathematical concepts used in computer science CO 2. Apply knowledge of Mathematics and linear Algebra in solving problems related to computer Science and Engineering CO 3. Analyze and compare the properties of various Mathematical techniques CO 4. Model Engineering problems with the concepts and techniques of Mathematics

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Programme Specific Elective (PSE) Courses

Name of the Programme	**: M.E in Information Technology Engineering**
Course code	**: ITH-531**
Title of the course	**: Mobile and Pervasive Computing**
Number of Credits	**: 4 (4L)**
Effective from AY	**: 2024-25**

Pre-requisites for the Course:	Basics of wireless communication	
Course Objectives:	This course will enable students to: 1. Understand the Emerging Technologies in Wireless Networks. 2. Explain about the Transmission Methods and Data Management. 3. Compare the working of wireless Routing Protocols. 4. Outline the characteristics of Pervasive Computing Applications including the major system components & architectures of the systems.	
Contents:	**Topics**	**No. of Hours**
Unit 1	**Introduction to Pervasive Computing:** Internet and Ubiquitous computing, Pervasive Computing and Ubiquitous Computing, Ambient Computing. **Wireless Networks:** Emerging technologies- Blue tooth, Wi-Fi, WiMAX, 3G, WATM-Mobile IP protocols -WAP push architecture-WML scripts and applications. **Mobile Computing:** Mobile computing environment—functions-architecture-design considerations, content architecture- CC/PP exchange protocol, context manager. Data management in WAE-Coda file system- caching schemes-Mobility QOS. Security in mobile computing.	**15**
Unit 2	**Pervasive Computing**: Pervasive Computing – Principles, Characteristics- interaction transparency, context aware, automated experience capture. Architecture for pervasive computing- Pervasive devices-embedded controls- smart sensors and actuators -Context communication and access services. **Architecture:** Requirements of computational infrastructure failure management security performance dependability Pervasive Computing devices and Interfaces Device technology trends, Connecting issues and protocols.	**15**
Unit 3	**Location Management:** Handoff in wireless mobile networks-model-handoff schemes. Location management in cellular networks - Mobility models- location and tracking management schemes- time, movement, profile and distance-based update strategies. ALI technologies. **WAP & WML:** Pervasive Computing and web-based Applications XML and its role in Pervasive Computing, Wireless Application Protocol (WAP) Architecture and Security Introduction to Wireless Mark-Up language (WML).	**15**

	PDA In pervasive computing: Introduction, PDA software Components, Standards, emerging trends, PDA Device characteristics, PDA Based Access Architecture.	
Unit 4	**Pervasive Computing and Security:** Voice Enabling Pervasive Computing Voice Standard Speech Applications in Pervasive Computing and security. **Service Discovery:** Open protocols- Service discovery technologies- SDP, Jini, SLP, UpnP protocols–data synchronization SyncML framework - Context aware mobile services -Context aware sensor networks, addressing and communications. Context aware security.	**15**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books:** 1. Asoke K Talukder, Hasan Ahmed, Roopa R Yavagal, “Mobile Computing: Technology, Applications & Service Creation” 2nd Edition, Tata McGraw Hill Education Pvt Ltd, 2005 7 West Patel Nagar, New Delhi 110008 (ISBN (13): 978-0-07-014457-6, ISBN (10): 0-07-014457-5) 2. Ivan Stojmenovic, “Handbook of Wireless Networks and Mobile Computing”, A Wiley-Interscience Publication, John Wiley & sons Inc, 2nd Edition, Canada, 2002. (Print ISBN:9780471419020, Online ISBN:9780471224563 3. Uwe Hansman, Lothat Merk, Martin S Nicklous & Thomas Stober, “Principles of Mobile Computing”, Second Edition, Springer, Verlag, New Delhi, 2003. **Reference Books:** 1. Frank Adelstein Sandeep K. S. Gupta Golden G. Richard III Loren Schwiebert, “Fundamentals of Mobile and Pervasive Computing”, McGraw-Hill, 2nd Edition 2005. 2. Jochen Burkhardt, “Pervasive Computing: Technology and Architecture of Mobile Internet Applications”, Pearson Education, 2nd Edition, 2009.	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the concept of wireless networks, transmission methods & data management. CO 2. Develop Markup language for wireless application protocols. CO 3. Compare the working of wireless routing protocols. CO 4. Apply Pervasive techniques to real world problems.	

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Name of the Programme : **M.E in Information Technology Engineering**
Course code : **ITH-532**
Title of the course : **Natural Language Processing**
Number of Credits : **4 (4L)**
Effective from AY : **2024-25**

Pre- requisites for the Course:	Fundamentals of Machine Learning	
Course Objectives:	This course will enable students to: 1. Understand Natural Language processing 2. Explain about parsing, sentiment analysis and speech processing 3. Analyse different semantics. 4. Implement Sentiment analysis and Speech processing	
Contents:	**Topics**	**No. of Hours**
Unit 1	**Foundations of Natural Language Processing:** Introduction, Natural Language Processing - Problems and perspectives, Introduction to probability calculus, N-grams and Language Models, Markov Models, Introduction to Machine Learning and Deep Learning, Recurrent Neural Network Language Models, The evaluation of NLP applications. **Corpora and their construction:** representativeness, Concordances, collocations and measures of words association, Methods for Text Retrieval, Regular expressions. **Shallow Parsing:** Part-of-Speech Tagging, Statistical POS Tagging, Neural POS Tagging, Chunking	**15**
Unit 2	**Deep Parsing:** Linguistics of Parsing, Algorithmic of Parsing, Constituency Parsing: Rule Based, Statistical Parsing, Dependency Parsing, Neural Parsing. **Computational Phonetics and Speech Processing:** Speech samples: properties and acoustic measures, Analysis in the frequency domain, Spectrograms, Applications in the acoustic-phonetic field. Speech recognition with HMM and Deep Neural Networks, Tokenisation and Sentence splitting, Computational Morphology: Morphological operations, Static lexica, Two-level morphology, Computational Syntax, Part-of-speech tagging, Grammars for natural language, Natural language Parsing, Supplementary worksheet: formal grammars for NL	**15**
Unit 3	**Computational Semantics:** Lexical semantics: WordNet and Frame Net, Word Sense Disambiguation, Distributional Semantics & Word-Space models, Logical approaches to sentence semantics. **Sentiment Analysis:** Problem Statement, Ambiguity for Sentiment Analysis, Lexicons for Sentiment Analysis, Rule-Based Sentiment Analysis, Statistical Sentiment Analysis, Neural Approaches to Sentiment Analysis, Sentiment Analysis in Different Languages	**15**

Unit 4	**Applications and Case studies:** Solving Downstream Tasks: Document classification, Sentiment Analysis, Named Entity Recognition, Semantic Textual Similarity, Prompting Pre-Trained Language Models, Network Embedding **Question Answering:** Problem Formulation, Ambiguity in Question Answering, Dataset Creation, Rule-based Q&A, Second Generation, Third Generation **Conversational AI:** Problem Definition, Ambiguity Resolution in Conversational AI, Rule-Based Approaches to Conversational AI, Statistical Approaches, Neural Approaches	**15**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books** 1. Allen, James, "Natural Language Understanding", 2nd Edition, Benjamin/Cumming, 2018. 2. Pushpak Bhattacharya and Aditya Joshi, "Natural language Processing", Wiley Emerging Technology Series, 1st edition, 2019. **Reference Books** 1. Jurafsky, Dan and Martin, James, "Speech and Language Processing", 2nd Edition, Prentice Hall, 2008. 2. Manning, Christopher and Heinrich, Schutze, "Foundations of Statistical Natural Language Processing", MIT Press, 1st Edition, 1999. 3. Tamburini, F., "Neural Models for the Automatic Processing of Italian", Bologna: Pàtron. 2022.	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the basic concepts in natural language processing and different areas in Natural Language Processing. CO 2. Apply the Natural Language Processing algorithms. CO 3. Analyse the association of Natural Language Processing with Artificial Intelligence CO 4. Develop Natural Language Processing models contributing towards real life linguistic problem.	

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Research Specific Elective (RSE) Courses

Name of the Programme : M.E in Information Technology Engineering
Course code : REC-561
Title of the course : Engineering Research & Publication
Number of credits : 4(3L+1T)
Effective from AY : 2024-25

Pre-requisites for the Course:	Knowledge of research requirements in real life	
Course Objectives:	The course will enable the students to 1. Understand the importance of literature review, defining the research objectives. 2. Explain qualitative and quantitative methods of data analyses and its importance. 3. Classify research publications, select appropriate journals based on research areas. 4. Practice ethics in publication and academic integrity	
Content:		**No of Hours**
Unit -1	**Overview of scientific research in engineering**, foundational and fundamental concepts like types of research and considerations for research in specific domains, motivation to do research, critical thinking, assumptions and hypotheses, basic and applied research, importance of formulation of broad research objectives	**11 + 4T**
Unit -2	**Purpose and Methodology of Literature Search and Review** of the scientific and engineering publications. Sources such as scholarly databases, public domain, open access, current literature, review articles, critical review and gap analysis, defining research objectives	**11 + 4T**
Unit -3	**Quantitative and qualitative Data –** importance of data in research, types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, mathematical modeling, simulation, experimental data, optimization methods; Qualitative data collection, preparing questioners, rating scale, conducting survey, validation of models.	**12 + 4T**
Unit- 4	**Preparation of Publications-** Elements of research publications, types of publications, writing for journal publications, basic requirements for publication, selection of journals, journal quality indicators, peer review, reply to comments and responses, publication ethics, references, citations, authorship, plagiarism, academic integrity	**11 + 3T**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning , Constructive learning and Collaborative learning	
References/ Readings:	1. Herman Tang, 'Engineering Research-Design, Methods and Publications', John Wiley and Sons, 2021, ISBN:9781119624486. 2. Michael Jay Katz, 'From Research to Manuscript', Springer Publication,	

	2009, ISBN:9781402094668. 3. Rob Dekkers, Lindsey Casey, Peter Langhorne, 'Making Literature Review Work', Springer Publications, 2022, ISBN:9783030900243 4. Meikang Qiu, Han Qiu, Yi Zeng, 'Research & Technical Writing for Science and Engineering', Taylor & Francis Publications, 2022, ISBN:9781003139058.
Course Outcomes:	CO 1. Understand the importance of literature review, defining the research objectives. CO 2. Explain qualitative and quantitative methods of data analyses and its importance. CO 3. Classify research publications, select appropriate journals based on research areas. CO 4. Practice ethics in publication and academic integrity

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Knowledge is Divine

Name of the Programme : **M.E in Information Technology Engineering**
Course code : **REC-562**
Title of the course : **Literature Review & Technical Writing for Engineers**
Number of credits : **4(3L + 1T)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basics of Technical writing skills.	
Course Objectives:	The course will enable the students to 1. Understand the importance of literature review and writing a review paper. 2. Explain the method to be followed to write a review paper. 3. Classify data for qualitative and quantitative analysis 4. Demonstrate technical writing for conference.	
Content:		**No of Hours**
Unit -1	**Overview on Literature Review**, difference between objectives of literature review and research objectives; types of literature review, qualitative and quantitative reviews, search strategies, primary and secondary sources, database search strategies, field search, root search, complimentary search, meta-analysis	**12 + 4T**
Unit -2	**Database management of literature reviews**, bibliometric analysis, importance of writing a review paper, reply to comments and responses, publication ethics, references, citations, authorship, plagiarism, academic integrity; public domain, open access, current literature.	**11 + 4T**
Unit -3	**Technical writing on a specific research topic**, structure of the paper, abstract, introduction, experimental, simulation, analysis, discussion, inferences, title, acknowledgment, referencing, presentation of tables, figures, graphs, equations; comparison between technical writing for conference papers and journal paper	**11 + 4T**
Unit- 4	**Importance of data in research**, types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, mathematical modeling, simulation, experimental data, optimization methods; Qualitative data collection, preparing questioners, rating scale, conducting survey, validation of models.	**11 + 3T**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Rob Dekkers, Lindsey Casey, Peter Langhorne, 'Making Literature Review Work – Multidisciplinary Guide to Systematic Approaches', Springer Publications, 2022, ISBN:9783030900243. 2. Michael Jay Katz, 'From Research to Manuscript', Springer Publication, 2009, ISBN:9781402094668. 3. Herman Tang, 'Engineering Research-Design, Methods and Publications', John Wiley and Sons, 2021, ISBN:9781119624486. 4. Meikang Qiu, Han Qiu, Yi Zeng, 'Research & Technical Writing for	

	Science and Engineering', Taylor & Francis Publications, 2022, ISBN:9781003139058.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of literature review and writing a review paper. CO 2. Explain the method to be followed to write a review paper. CO 3. Classify data for qualitative and quantitative analysis CO 4. Demonstrate technical writing for conference.

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SEMESTER II
Programme Specific Core Courses
Name of the Programme : M.E in Information Technology Engineering (RC 2024-25)
Course code : ITH-505
Title of the course : Data Analytics and Visualization
Number of Credits : 3 (3L)
Effective from AY : 2024-25

Pre-requisites for the Course:	Fundamentals of data mining	
Course Objectives:	This course will enable students to: 1. Understand the concept of data analytics life cycle. 2. Develop mathematical concept required for advance regression. 3. Create awareness about text analytics and its application. 4. Learn concepts of data analytics and visualization with R and Python.	
Contents:	**Topics**	**No. of Hours**
Unit 1	**Data Analytics Lifecycle overview:** Key Roles for a Successful Analytics, Background and Overview of Data Analytics Lifecycle Project Phase 1: Discovery: Learning the Business Domain, Resources Framing the Problem, Identifying Key Stakeholders. Interviewing the Analytics Sponsor, Developing Initial Hypotheses Identifying Potential Data Sources Phase 2: Data Preparation: Preparing the Analytic Sandbox, Performing ETLT, Learning About the Data, Data Conditioning, Survey and visualize, Common Tools for the Data Preparation Phase Phase3: Model Planning: Data Exploration and Variable Selection, Model Selection, Common Tools for the Model Planning Phase , Phase 4: Model Building: Common Tools for the Model Building Phase ,Phase 5: Communicate Results, Phase 6: Operationalize **Big Data and Cloud technologies:** Introduction to HADOOP: Big Data, Apache Hadoop, MapReduce - Data Serialization - Data Extraction - Stacking Data - Dealing with data. **Introduction to R:** Data Import and Export, Attribute and Data type, Descriptive statistics. Exploratory Data Analysis: Visualization before analysis, Dirty Data, visualizing single variable, examining Multiple variables, Data Exploration versus presentation.	**12**
Unit 2	**Data analytics and Visualization with Python:** Essential Data Libraries for data analytics: Pandas, NumPy, SciPy. **Plotting and visualization with python:** Introduction to Matplotlib, Basic Plotting with Matplotlib, Create Histogram, Bar Chart, Pie chart, Box Plot, violin plot using Matplotlib, Introduction to seaborn Library, Multiple Plots, Regression plot, regplot **Advanced Pandas:** Categorical Data, Advanced GroupBy Use, Techniques for Method Chaining.	**11**

Unit 3	**Regression Models:** Introduction to simple Linear Regression: The Regression Equation, fitted value and Residuals, Least Square Introduction to Multiple Linear Regression: Assessing the Model, Cross-Validation, Model Selection and Stepwise Regression, Prediction Using Regression **Logistic Regression:** Logistic Response function and logit, Logistic Regression and GLM, Generalized Linear model, predicted values from Logistic Regression, Interpreting the coefficients and odds ratios, Linear and Logistic Regression: similarities and Differences, Assessing the models	**11**
Unit 4	**Overview of Time Series:** Analysis Box-Jenkins Methodology, ARIMA Model Autocorrelation Function (ACF), Auto regressive Models, Moving Average Models, ARMA and ARIMA Models, Building and Evaluating an ARIMA Model, Reasons to Choose and Cautions. **Text Analytics:** History of text mining, Roots of text mining overview of seven practices of text analytic, Application and use cases for Text mining: extracting meaning from unstructured text, Summarizing Text. Text Analysis Steps, A Text Analysis Example, Collecting Raw Text, Representing Text, Term Frequency—Inverse Document Frequency (TFIDF), Categorizing Documents by Topics, Determining Sentiments, Gaining Insights.	**11**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books:** 1. Bharati Motwani, "Data Analytics using Python", Wiley Publications, 2nd Edition, 2020, ISBN-13 978-8126502950. 2. EMC Education Services, "Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data", Wiley Publication, 1st Edition, 2015, ISBN-13 978-1118876138. **Reference Books:** 1. Grey Miner, Andrew Fast, "Practical Text Mining and statistical Analysis for non-structured text data applications", Elsevier, 1st edition, 2012, ISBN-13 978-0123869791. 2. Peter Bruce, Andrew Bruce, Peter Gedeck, "Practical Statistics for Data Scientists 50+ Essential Concepts Using R and Python", O'Reilly Publications, 2nd Edition, 2020, ISBN-13 978-1492072942.	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the basics of data analytics and visualization. CO 2. Apply various regression models on given data set and perform prediction. CO 3. Analyse text data and gain insight. CO 4. Apply different analytic techniques and visualization using R and python.	

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Name of the Programme : M.E in Information Technology Engineering (RC 2024-25)
Course code : ITH-506
Title of the course : Data Analytics Lab
Number of Credits : 1 (1P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basics of data mining and programming language	
Course Objectives:	This course will enable students to: 1. Use time series model for prediction. 2. Understand the concepts of text analysis and its application. 3. Apply suitable visualization techniques using R and python. 4. Use libraries for data analytics.	
Contents:	**Topics**	**No. of Hours**
	(Any 8 Sample experiments can be implemented in the following areas) 1. Introduction to data analytics libraries in Python and R. 2. Implementation of Linear Regression in Python/R. 3. Implementation of multiple Linear Regression in Python/R. 4. Implementation of Logistic regression on suitable data set in python. 5. Implementation of Time series analysis in Python/R. 6. Implementation of ARIMA model in python / R. 7. Implementation of text classification using cross validation. 8. Implementation of Spam filter in python/R. 9. Implementation of Sentiment analysis in python/R. 10. Implementation of text summarization in python/R 11. Implementation of data visualization experiments in R using different Libraries. 12. Implementation of data visualization experiments in python using different Libraries. 13. Working with Hadoop. 14. Implementation of word count program example using MapReduce. 15. Implementation of clustering algorithm using MapReduce.	**30**
Pedagogy:	Constructive, Collaborative and Inquiry Based Learning	
Instructions:	Minimum 8 experiments to be performed from above list.	
References/ Readings:	**Text Books:** 1. Bharati Motwani, “Data Analytics using Python”, Wiley Publications, 2^{nd} Edition, 2020, ISBN-13 978-8126502950. 2. EMC Education Services, “Data Science and Big Data Analytics: Discovering, Analyzing, Visualizing and Presenting Data”, Wiley Publication, 1^{st} Edition, 2015, ISBN-13 978-1118876138. **Reference Books:** 1. Grey Miner, Andrew Fast, “Practical Text Mining and statistical Analysis for non-structured text data applications”, Elsevier, 1^{st} edition, 2012, ISBN-13 978-0123869791.	

	2. Peter Bruce, Andrew Bruce, Peter Gedeck, “Practical Statistics for Data Scientists 50+ Essential Concepts Using R and Python”, O‘Reilly Publications, 2nd Edition, 2020, ISBN-13 978-1492072942.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explore various data Analytics libraries in R and Python CO 2. Build various time Series models on a given data set CO 3. Design Text analytics application on given data sets. CO 4. Implement visualization techniques to given data set using R and Python.

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Name of the Programme : **M.E in Information Technology Engineering (RC 2024-25)**
Course code : **ITH-507**
Title of the course : **Information Assurance and Security**
Number of Credits : **3 (3L)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge on data security and IOT	
Course Objectives:	This course will enable students to: 1. Grasp an integrated security view covering the computer, the operating system and the databases. 2. Understand the basic elements of encryption and their use in digital signatures and authentication. 3. Learn the basic concepts of IP and Web security.	
Contents:	**Topics**	**No. of Hours**
Unit 1	**Introduction:** Security Threats in Information systems, Programs, operating system, and database security and integrity. Network security models Computer Security Hardware vulnerabilities, Virus and other malicious programs, Virus counter measures, Intrusion techniques and detection, Password management Operating System security, Models of operating system security, User authentication, Design of secure operating systems, Operating system certification. Database security and integrity, Overview and policies for database security, Models for database access control, Information flow model, Authorization techniques, Auditing and control.	**12**
Unit 2	**Data hiding techniques:** Cryptography, Public Key distribution &random number generation, Public Key cryptography and RSA. Hash functions, Steganography, Digital Watermarking **Digital signatures, Intellectual Property rights:** Copyrights, trademarks and patents.	**11**
Unit 3	**IP and Web security:** Authentication protocols, IP security architecture, IPSec protocol, Web security considerations, Secure Socket Layer and Transport layer Security, Secure Electronic Transactions.	**11**
Unit 4	**Security in IoT:** Security Requirements in IoT Architecture, Security in Enabling Technologies, Security Concerns in IoT Applications. Security Architecture in the Internet of Things, Security Requirements in IoT, Insufficient Authentication/Authorization, Insecure Access Control, Threats to Access Control, Privacy, and Availability, Attacks Specific to IoT. Vulnerabilities, Secrecy and Secret, Key Capacity, Authentication/Authorization for Smart Devices, Transport Encryption, Attack and Fault trees, IoT system implementation life cycle.	**11**

Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning
References/ Readings:	**Text Books:** 1. Timothy Stapko, "Practical Embedded Security: Building Secure Resource Constrained Systems", Elsevier, 1st Edition, 2009, ISBN 978-007-127189-9. 2. William Stallings, "Cryptography and Network Security: Principles and Practice", Pearson, 3rd Edition, 2002, ISBN-13978-0130914293. **Reference Books:** 1. Ingemer Cox, Mathew Miller, Jeffrey Bloom, "Digital watermarking: Principles & Practices", Morgan Kaufmann Series, 1st Edition, 2001, ISBN-13978-1558607149. 2. Michael Whitman, Herbert Mattord, "Guide to firewalls & network security: with intrusion detection & VPNs, Course Technology", Delmar Cengage Learning, 2nd Edition,2008, ISBN-13 978-1435420168. 3. SD Stinson "Cryptography: Theory and Practice", Chapman and HALL/CRC Press, 3rd Edition, 2005, ISBN-13 978-1584885085.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the security of the different components of information systems. CO 2. Apply encryption techniques& their applications in providing security. CO 3. Evaluate basic IP and Web security protocols and understand security in an IoT environment. CO 4. Implement data hiding techniques.

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Name of the Programme : **M.E in Information Technology Engineering (RC 2024-25)**
Course Code : **ITH-508**
Title of the course : **Information Assurance and Security Lab**
Number of Credits : **1 (1P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of security.	
Course Objectives:	This course will enable students to: 1. Grasp an integrated security view covering the computer, the operating system and data. 2. Learn the basic elements of encryption and their use in digital signatures and authentication. 3. Understand IoT security implementations.	
Contents:	**Topics**	**No. of Hours**
	(Any 8 Sample experiments can be implemented in the following areas) 1. Implement basic encryption ciphers 2. Implement an asymmetric encryption algorithm 3. Implement a hybrid secure cryptographic system. 4. Implement hashing. 5. Implement Watermarking (Coding) 6. Implement steganography 7. Create a digital signature 8. Implement packet tracing tools 9. Demonstrate techniques for secure data storage, secure data transmission and for creating digital signatures (GnuPG) 10. Setup a honeypot and monitor the honeypot on network (KF Sensor) 11. Perform wireless audit on access point or a router and decrypt WEP and WPA (Net Stumbler) 12. Demonstrate intrusion detection system (ids) using any tool (snort or any other s/w). 13. Identifying procedures to create/ obtain Copyrights, trademarks and patents 14. Implement password cracking. 15. Implement Security techniques in an IoT application.	**30**
Pedagogy:	Constructive, Collaborative and Inquiry Based Learning	
Instructions:	Minimum 8 experiments to be performed from above list.	
References/ Readings:	**Text Books:** 1. Timothy Stapko, “Practical Embedded Security: Building Secure Resource Constrained Systems”, Elsevier, 1st Edition, 2009, ISBN 978-007-127189-9. 2. William Stallings, “Cryptography and Network Security: Principles and Practice”, Pearson, 3rd Edition, 2002, ISBN-13 978-0130914293. **Reference Books:** 1. Ingemer Cox, Mathew Miller, Jeffrey Bloom, “Digital watermarking:	

	Principles & Practices", Morgan Kaufmann Series, 1st Edition, 2001, ISBN-13978-1558607149. 2. Michael Whitman, Herbert Mattord, "Guide to firewalls & network security: with intrusion detection & VPNs, Course Technology", Delmar Cengage Learning, 2nd Edition,2008, ISBN-13 978-1435420168. 3. SD Stinson "Cryptography: Theory and Practice", Chapman and HALL/CRC Press, 3rd Edition, 2005, ISBN-13 978-1584885085.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the techniques of encryption, steganography, generating digital signatures. CO 2. Implementing encryption techniques & their applications in providing security. CO 3. Implement Intrusion detection and packet tracing.

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Name of the Programme : **M.E in Information Technology Engineering (RC 2024-25)**
Course code : **ITH-509**
Title of the course : **Algorithm Design and Optimization**
Number of Credits : **3 (3L)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge on design of algorithms	
Course Objectives:	**This course will enable students to:** 1. Understand and choose the appropriate algorithm design technique for a specified application. 2. Learn concepts of convex analysis and convex optimization problems. 3. Solve problems using algorithm design paradigms. 4. Apply convex optimization concept to solve engineering problems.	
Contents:	**Topics**	**No. of Hours**
Unit 1	**Review of Basic Algorithmic Design Techniques:** Divide and Conquer Technique, Greedy technique, Dynamic programming, Backtracking, Branch and Bound. **NP, Completeness and the P & NP Classes:** Introduction, Polynomial Time & Verification, NP, NP Hard, NP Completeness and Reducibility, Traveling Salesman Problem, Knapsack, Set Cover.	**11**
Unit 2	**Randomized Algorithms:** Introduction, Type of Randomized Algorithms, Quick Sort, Min-cut, 2-SAT, Game Theoretic techniques, Random Walks. **Approximation Algorithms:** Introduction, Greedy Algorithms, Travelling Salesman Problem, Dynamic Programming, Knapsack Problem.	**11**
Unit 3	**Convex Sets and Functions:** Optimization problems, Convex Optimization, Equivalent optimization problems. Convex sets and functions, Operations that preserve convexity, Separating and supporting hyperplanes, Cones and Generalized inequalities. **Convex Optimization Problems:** Convex optimization, Linear and quadratic programming, Geometric programming, generalized inequality constraints, Vector optimization. **Applications:** Approximation and fitting, Statistical estimation, Chebyshev and Chernoff bounds, Geometric problems & Classification.	**12**
Unit 4	**Unconstrained and Equality Constrained Minimization:** Descent methods, Gradient and steepest descent methods, Newton's method, Newton's method with equality constraints, Infeasible start Newton method**.**	**11**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books:** 1. Boyd and Vandenberghe, "Convex Optimization", Cambridge University Press, 1st Edition, 2004, ISBN-13 978-0521833783. 2. Cormen, Leiserson, Rivest, Stein, "Introduction to Algorithm", PHI, 4th	

	Edition, 2022. **Reference Books:** 1. Anany V. Levitin, “Introduction to the Design and Analysis of Algorithms”, Pearson Education publication. 3rd Edition, 2017, ISBN-13 978-9332585485. 2. Nisheeth K. Vishnoi, “Algorithms for convex optimization”, Cambridge university Press, 1st Edition ,2021, ISBN-13 9781108741774. 3. Parag Dave & Himanshu Dave, “Design and Analysis of Algorithms”, Pearson Education, 2nd Edition ,2013, ISBN-13 978-8131799437.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Identify important algorithmic design paradigms to model engineering problem. CO 2. Apply the different algorithmic design paradigms to obtain solution to the problem. CO 3. Analyse the various optimization algorithm to solve a problem for optimal solution. CO 4. Implement the efficient algorithm to get optimal solution to engineering problem.

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Name of the Programme : **M.E in Information Technology Engineering (RC 2024-25)**
Course Code : **ITH-510**
Title of the course : **Algorithm Design and Optimization Lab**
Number of Credits : **1 (1P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of programming.	
Course Objectives:	This course will enable students to: 1. Understand computational models to identify the complexity/ performance of different algorithms. 2. Apply the algorithm design techniques to a problem 3. Analyze the lower and upper bounds of various problems and their importance in deciding the optimality of an algorithm. 4. Implement algorithms to get optimal solution to engineering problems.	
Contents:	**Topics**	**No. of Hours**
	(Any 8 Sample experiments can be implemented in the following areas) 1. Implement Branch & bound technique 2. Implement different sorting algorithm and calculate worst time complexity using different data sets 3. Implement different searching algorithm and calculate worst time complexity using different data sets 4. Implement different methods for solving recurrence for an application. 5. Implement randomized Quicksort & min cut algorithm technique 6. Implement randomized 2-SAT technique 7. Implement Greedy algorithm for a given dataset 8. Implement dynamic programming approach to solve a knapsack problem for a given dataset 9. Implement approximation algorithm. 10. Implement the different operations that preserve the convexity of separating the hyperplanes. 11. Implement linear regression for convex optimization 12. Implement logistic regression for convex optimization 13. Implement Gradient and steepest descent methods for convex optimization. 14. Implement Geometric programming for a given data set 15. Implement Newton's method with equality constraints.	**30**
Pedagogy:	Constructive, Collaborative and Inquiry Based Learning	
Instructions:	Minimum 8 experiments to be performed from above list.	
References/ Readings:	**Text Books:** 1. Boyd and Vandenberghe, "Convex Optimization", Cambridge University Press, 1st Edition, 2004, ISBN-13 978-0521833783. 2. Cormen, Leiserson, Rivest, Stein, "Introduction to Algorithm", PHI, 4th	

Issued on: 29/01/2025

	Edition, 2022. **Reference Books:** 1. Anany V. Levitin, "Introduction to the Design and Analysis of Algorithms", Pearson Education publication. 3rd Edition, 2017, ISBN-13 978-9332585485. 2. Nisheeth K. Vishnoi, "Algorithms for convex optimization", Cambridge university Press, 1st Edition ,2021, ISBN-13 9781108741774. 3. Parag Dave & Himanshu Dave, "Design and Analysis of Algorithms", Pearson Education, 2nd Edition ,2013, ISBN-13 978-8131799437.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain computational models to identify the complexity/performance of different algorithms. CO 2. Demonstrate usage of the algorithm design techniques for a problem CO 3. Analyse the lower and upper bounds of various problems and their importance in deciding the optimality of an algorithm. CO 4. Apply the efficient algorithmic techniques to get optimal solution to engineering problem.

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Programme Specific Elective (PSE) Courses

Name of the Programme	**: M.E in Information Technology Engineering (RC 2024-25)**
Course code	**: ITH-533**
Title of the course	**: Smart Robots**
Number of Credits	**: 3 (3L)**
Effective from AY	**: 2024-25**

Pre-requisites for the Course:	Basics of Artificial Intelligence and Machine Learning	
Course Objectives:	This course will enable students to: 1. Understand the Emerging Technologies in Wireless Networks. 2. Explain about the Transmission Methods and Data Management. 3. Compare the working of wireless Routing Protocols. 4. Learn the characteristics of Pervasive Computing Applications including the major system components & architectures of the systems.	
Contents:	**Topics**	**No. of Hours**
Unit 1	**Introduction to Smart Robots:** Overview of robotics and intelligent systems, History and evolution of smart robots, Key components and technologies, Artificial Intelligence in Robotics, Smart robotic systems in various domains.	**11**
Unit 2	**Introduction to AI and ML:** Robotics applications of AI, Introduction to ML, Robotics applications of ML, Case studies.	**10**
Unit 3	**Machine Vision Systems:** Machine Vision Definition, Origins of Machine Vision, Relation to Human Vision, Basis for a General Purpose Image Understanding System, Basic Paradigms for Machine Vision, Hierarchical Bottom-Up Approach, Hierarchical Top-Down Approach Hierarchical Approach, Blackboard Approach, Levels of Representation , Representation Methods and Techniques , Low Level Features, Extracting Edges and Areas, Segmentation and Interpretation, 2-D Representation, Description and Recognition	**12**
Unit 4	**Smart Robotic Systems Design and Development:** Design principles and methodologies, Development tools and frameworks **Applications and Future Directions**: Internet of Robotic Things, Future directions and challenges.	**12**
Pedagogy:	Inquiry Based Learning, Reflective, Integrative Learning	
References/ Readings:	**Text Books:** 1. Dr. Robotics, "Smart Robots: Fundamentals, Technologies, and Applications" . 2. V. Daniel Hunt, “Smart Robots, A Handbook of Intelligent Robotic Systems”, Springer-Verlag New York Inc., 1st Edition, 2011, ISBN-13978-1461295846. **Reference Books:** 1. Nitin Goyal, Sharad Sharma, Arun Kumar Rana, Suman Lata Tripathi, “Internet of things – Robotics and Drone Technology”, CRC Press, 1st	

	Edition, 2022, ISBN-13978-1032020532.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the basics of robotics and intelligent systems. CO 2. Analyse and evaluate the performance of smart robotic systems. CO 3. Apply smart robotic systems in various domains (e.g., healthcare, manufacturing, transportation). CO 4. Design and develop smart robotic systems using AI and ML techniques.

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Name of the Programme : M.E in Information Technology Engineering (RC 2024-25)
Course Code : ITH-534
Title of the course : Smart Robots Lab
Number of Credits : 1 (1P)
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic knowledge of Artificial Intelligence and programming language	
Course Objectives:	This course will enable students to: 1. Understand the fundamental concepts and technologies behind smart robots 2. Learn to design, develop, and deploy intelligent robotic systems that can interact with and adapt to their environment.	
Contents:	**Topics**	**No. of Hours**
	(Any 8 Sample experiments can be implemented in the following areas) 1. Comparative study of Arduino Microcontroller and Raspberry Pi SoC and its application in Smart Robotics. 2. Develop a system for a smart dustbin. 3. Develop a system for smart solar panel. 4. Develop a system for firefighting robot. 5. Develop a system for smart irrigation system. 6. Study of AI based Virtual Reality Robotic Gadgets. 7. Case study of Smart industry and its applications. 8. Case study of Robotic Défense applications. 9. Develop any IIOT robotic application for industry 4.0 10. Develop a system for a surveillance robot. 11. Develop mobile app-controlled home cleaning robot. 12. Develop a system for gesture based smart robotic arm. 13. To develop obstacle avoidance robot 14. To develop an edge detection robot 15. To develop path finding robot	**30**
Pedagogy:	Constructive, Collaborative and Inquiry Based Learning	
Instructions:	Minimum 8 experiments to be performed from above list.	
References/ Readings:	**Text Books:** 1. "Smart Robots: Fundamentals, Technologies, and Applications" by Dr. Robotics 2. V. Daniel Hunt, “Smart Robots, A Handbook of Intelligent Robotic Systems”, Springer-Verlag New York Inc., 1st Edition, 2011, ISBN-13978-1461295846. **Reference Books:** 1. Nitin Goyal, Sharad Sharma, Arun Kumar Rana, Suman Lata Tripathi, “Internet of things – Robotics and Drone Technology”, CRC Press, 1st Edition, 2022, ISBN-13978-1032020532.	
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the working of robotics and intelligent systems. CO 2. Apply smart robotic systems in related domains	

	CO 3. Analyse the performance of smart robotic systems. CO 4. Design and develop smart robotic systems using AI and ML techniques.

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Name of the Programme : **M.E in Information Technology Engineering (RC 2024-25)**
Course code : **ITH-535**
Title of the course : **Grid Computing**
Number of Credits : **3 (3L)**
Effective from AY : **2024-25**

<table>
<tr><td>Pre- requisites for the Course:</td><td colspan="2">Basics of Computing</td></tr>
<tr><td>Course Objectives:</td><td colspan="2">This course will enable students to:
1. Understand how Grid computing helps in solving large scale scientific problems.
2. Gain knowledge on various grid technologies and architectures.
3. Learn the security issues in the grid environment</td></tr>
<tr><td>Contents:</td><td>Topics</td><td>No. of Hours</td></tr>
<tr><td>Unit 1</td><td>Introduction to grid computing: Grid terms and concepts, entering into grid, Definitions, Grid layered architecture, Distributed Computing, Computational grids, data grids.
The Grid Computing anatomy: The grid problem, concept of virtual organizations.
Conceptual Evolution and Pathway to Grid computing: Introduction and evolution, concept of networking in grid, grid pathway, benefits of grid computing.</td><td>11</td></tr>
<tr><td>Unit 2</td><td>Service oriented architecture: SOA reference architecture, Design and development, Execution paradigm Web Services in grid.
XML related technologies and their role in grid: SOAP, WSDL, Global XML architecture, XML Messages and Enveloping, Service Message Description Mechanisms, Relationship between web service and grid service.</td><td>11</td></tr>
<tr><td>Unit 3</td><td>Grid user roles: User's perspective and Administrator's perspective.
Open grid service architecture (OGSA): OGSA architecture, Grid service description, OGSA core services.
Platform components: OGSA infrastructure.
OGSA basic services: Common management model, service domains, policy architecture, security architecture, Metering and accounting, Common Distributed logging.</td><td>11</td></tr>
<tr><td>Unit 4</td><td>Grid Computing security: Introduction, security Fundamentals, Authentication schemes, standard protocols, grid Taxonomy, Grid security infrastructure, Web services security.
Trust models for Grid security environment: Authentication and Authorization methods
Globus toolkit</td><td>12</td></tr>
<tr><td>Pedagogy:</td><td colspan="2">Inquiry Based Learning, Reflective, Integrative Learning</td></tr>
<tr><td>References/ Readings:</td><td colspan="2">Text Books:
1. Joshy Joseph, Craig Fellenstein, "Grid computing", Pearson Education, 1st Edition, 2004, ISBN-13 978-8131708859.</td></tr>
</table>

	2. P Venkata Krishna, M Rajasekhara Babu, "Principles of Grid computing", Ane Books Pvt. Ltd, 1st Edition, 2010, ISBN-13 978-9380618159. **Reference Books:** 1. Anirban Chakrabarti, "Grid Computing Security", Springer, 1st Edition, 2010, ISBN-13 978-3642079436 2. Bart Jacob, Michael Brown, Kentaro Fukui, Nihar Trivedi, "Introduction to grid computing", IBM Redbooks, 1st Edition, 2005, ISBN: 0738494003. 3. Barry Wilkinson, "Grid computing Techniques and Applications", Chapman & Hall/CRC Computational Science, 1st Edition, 2017, ISBN-13 978-1138116061.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the conceptual and practical aspects of Grid Computing. CO 2. Apply Grid computing techniques to solve problems CO 3. Analyse security issues in grid computing. CO 4. Create solutions for real life scenarios.

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Name of the Programme : **M.E in Information Technology Engineering (RC 2024-25)**
Course Code : **ITH-536**
Title of the course : **Grid Computing Lab**
Number of Credits : **1 (1P)**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basics of computing and programming languages	
Course Objectives:	This course will enable students to: 1. Understand how Grid computing helps in solving large scale scientific problems. 2. Gain knowledge on various grid technologies and architectures. 3. Understand the security issues in the grid environment	
Contents:	**Topics**	**No. of Hours**
	(Any 8 Sample experiments can be implemented in the following areas) 1. Study of Grid computing concepts and technologies 2. Study of Globus toolkit 3. Creating a simple web service 4. Develop a Web Service for Calculator 5. Develop new OGSA-compliant Web Service 6. Using Apache Axis develop a Grid Service. 7. Understanding some available Grid APIs in java/ C++ 8. Develop applications using Java or C/C++ Grid APIs 9. Study of security mechanisms in the Globus toolkit 10. Develop secured applications using basic security mechanisms available in Globus Toolkit. 11. Study of Resource scheduling in grid computing 12. Case study. 13. Develop a web service with inbuilt security of your choice 14. Develop a simple application using a globus toolkit 15. Study of different Grid computing scenarios and optimization.	**30**
Pedagogy:	Constructive, Collaborative and Inquiry Based Learning	
Instructions:	Minimum 8 experiments to be performed from above list.	
References/ Readings:	**Text Books:** 1. Joshy Joseph, Craig Fellenstein, “Grid computing”, Pearson Education, 1st Edition, 2004, ISBN-13 978-8131708859. 2. P Venkata Krishna, M Rajasekhara Babu, “Principles of Grid computing”, Ane Books Pvt. Ltd, 1st Edition, 2010, ISBN-13 978-9380618159. **Reference Books:** 1. Anirban Chakrabarti, “Grid Computing Security”, Springer, 1st Edition, 2010, ISBN-13 978-3642079436 2. Bart Jacob, Michael Brown, Kentaro Fukui, Nihar Trivedi, “Introduction to grid computing”, IBM Redbooks, 1st Edition, 2005, ISBN: 0738494003.	

	3. Barry Wilkinson, “Grid computing Techniques and Applications”, Chapman & Hall/CRC Computational Science, 1st Edition, 2017, ISBN-13 978-1138116061.
Course Outcomes:	After going through this course, the students will be able to: CO 1. Explain the conceptual and practical aspects of Grid Computing. CO 2. Apply Grid computing techniques to solve problems CO 3. Analyse security issues in grid computing. CO 4. Create solutions for real life scenarios.

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Research Specific Elective (RSE) Courses

Name of the Programme : M.E in Information Technology Engineering (RC 2024-25)
Course Code : REC-563
Title of the Course : Statistics and Data Analysis for Engineering Research
Number of Credits : 2
Effective from AY : 2024-25

Pre-requisites for the Course:	Basic Knowledge of Statistics	
Course Objectives:	The course will enable the students to 1. Explain the different types of data and parameter estimations 2. Explain standard probability distributions 3. Select the appropriate parameter estimation & distribution method 4. Co-relate different Hypotheses	
Content:		**No of Hours**
Unit -1	**Data Analysis:** Types of data, data collection techniques, Quantitative methods for analysis of data – statistical tools, experimental data, Qualitative data collection, questioners, rating scale, conducting survey. Statistical Modeling and Graphical Diagnostics - Scatter Plot, Stem-and-Leaf Plot, Histogram, Box Plot **Correlation and Regression Modeling:** Basic concept and numericals.	**9**
Unit -2	**Probability distributions and Sampling distributions:** Basic introduction to Bernoulli, Binomial and Normal distribution. Basic introduction to Sampling distributions- Normal, t-distribution, Chi-square and F- distributions.	**7**
Unit -3	**Parameter estimation:** Point Estimation – Concept, unbiased estimator, method of maximum likelihood. Parameter estimation of standard distributions- Binomial and Normal. Confidence Interval Estimation - Concept, Confidence interval on mean of single normal population with variance known, Confidence interval on the ratio of variances of two normal distributions	**7**
Unit- 4	**Tests of Hypotheses:** Introduction, Type I and type II errors, significance level and power of the test, Test of hypotheses - on mean of single normal population with variance known, on variance of single normal population.	**7**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. D. V Thiel, 'Research Methods for Engineers', Cambridge Press, 2014, ISBN:978-110-70-3-488 2. T. Mustafy, T. U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 3. D. C. Montgomery, C. G. Runger, 'Applied Statistics and Probability for Engineers', 6th Edition, Wiley India, 2016, ISBN 0-471-20454-4	

	4. R. E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye; Probability and Statistics for Engineers and Scientists ,9th Edition, Pearson Education India, 2013, ISBN 978-0-321-62911-1 5. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition, John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Explain the different types of data and probability distributions. CO 2. Select the appropriate parameter estimation & distribution method CO 3. Apply estimators for the given situations. CO 4. Evaluate Hypotheses based on the statistical considerations.

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Name of the Programme : **M.E in Information Technology Engineering (RC 2024-25)**
Course Code : **REC-564**
Title of the Course : **Statistics and Data Analysis Lab**
Number of Credits : **2**
Effective from AY : **2024-25**

<table>
<tr><td>Pre-requisites for the Course:</td><td colspan="2">Basic Knowledge of Statistics</td></tr>
<tr><td>Course Objectives:</td><td colspan="2">The course will enable the students to
1. Apply the different types of data and parameter estimations
2. Analyze standard probability distributions
3. Demonstrate parameter estimation & distribution methods
4. Co-relate different Hypotheses</td></tr>
<tr><td>Content:</td><td></td><td>No of Hours</td></tr>
<tr><td></td><td>Using open-source software like libreoffice or any proprietary software perform following experiments:
1. Obtain measures of central tendency and dispersion.
2. Obtain Quartiles, Percentiles and prepare Box-and-Whisker Diagram
3. Develop Pie chart, Bar Chart, Histogram and Stem-and-Leaf Plot,
4. Develop_correlation using Pearson's Correlation Coefficient and showing Scatter Diagrams and Trendlines
5. Develop Linear and Nonlinear Regression Models
6. Obtain probability values involving probability distributions – Binomial and Normal
7. Obtain values of Normal, t-distribution, Chi-square and F-statistic.
8. Develop confidence interval for single population and two populations with variance known.
9. Develop confidence interval on the ratio of variances of two normal distributions.
10. Perform test of hypotheses on mean/variance of single/ two population(s).</td><td>60</td></tr>
<tr><td>Pedagogy:</td><td colspan="2">Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning</td></tr>
<tr><td>References/ Readings:</td><td colspan="2">1. D. V Thiel, 'Research Methods for Engineers', Cambridge Press, 2014, ISBN:978-110-70-3-488
2. T. Mustafy, T. U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600.
3. D. C. Montgomery, C. G. Runger, 'Applied Statistics and Probability for Engineers', 6th Edition, Wiley India, 2016, ISBN 0-471-20454-4
4. R. E. Walpole, R. H. Myers, S. L. Myers, K. E. Ye; Probability and Statistics for Engineers and Scientists ,9th Edition, Pearson Education India, 2013, ISBN 978-0-321-62911-1
5. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition,</td></tr>
</table>

	John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Apply the different types of data and parameter estimations CO 2. Analyze standard probability distributions CO 3. Demonstrate parameter estimation & distribution methods CO 4. Co-relate different Hypotheses

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Name of the Programme : **M.E in Information Technology Engineering (RC 2024-25)**
Course Code : **REC-565**
Title of the Course : **Statistical Techniques for Engineering Research**
Number of Credits : **2**
Effective from AY : **2024-25**

Pre-requisites for the Course:	Basic knowledge of Statistics and Probability	
Course Objectives:	The course will enable the students to 1. Understand the importance of statistical methods for research 2. Select the appropriate factorial design method for a given set of experimental plan. 3. Apply basic probability theorems and draw relevant inferences. 4. Analyze suitable probability model for given set of data	
Content:		**No of Hours**
Unit-1	**Overview on Statistical methods**, collection of data, one dimensional and two-dimensional statistical analysis, computation of central tendency and dispersion for grouped and ungrouped data, correlation preliminary, understanding variability in data.	**6**
Unit-2	**Design of Experiments**, Preparation of experimental plan, full factorial design, fractional factorial design, identification of parameters and levels, randomization, replication, blocking, interaction; numerical; Optimization methods for two parameters.	**9**
Unit-3	**Probability Preliminary**: Introduction to Probability, definition, Sample Space, Events, Conditional Probability, Theorem on total probability, Bayes' theorem. Random Variable: Introduction, Discrete and Continuous distribution, Characteristics- Mean, Variance and distribution function.	**8**
Unit-4	**Probability and Sampling Distribution**: Bernoulli, Binomial, Exponential, Normal, distribution. Mean, variance and distribution function, important properties, approximations and applications. Statistic and Sampling Distribution: Population and Sample. Statistic, Sampling distributions- Normal, t-distribution, Chi-square and F- distributions.	**7**
Pedagogy:	Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning	
References/ Readings:	1. Tahvir Mustafy, Tauhid U Rahman, 'Statistics & Data Analysis for Engineers and Scientists', Springer, 2024, ISBN:9789819946600. 2. Jiju Antony, 'Design of Experiments for Engineers & Scientists', Elsevier, 2023, ISBN 978-044-315-1736 3. Douglas Montgomery, 'Design and Analysis of Experiments', Wiley India, Eighth Edition, 2013, 9788126540501 4. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010, ISBN: 9788126523504	

	5. R. Johnson, Probability and Statistics for engineers, Eighth Edition, Prentice Hall of India, New Delhi, 2015, ISBN 978-1-292-17601-7 6. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition, John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Understand the importance of statistical methods for research CO 2. Select the appropriate factorial design method for a given set of experimental plans. CO 3. Apply basic probability theorems and draw relevant inferences. CO 4. Analyze suitable probability model for given set of data

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Name of the Programme : **M.E in Information Technology Engineering (RC 2024-25)**
Course Code : **REC-566**
Title of the Course : **Probability & Statistical Analysis Lab**
Number of Credits : **2**
Effective from AY : **2024-25**

<table>
<tr><td>Pre-requisites for the Course:</td><td colspan="2">Basic knowledge of Statistics and Probability</td></tr>
<tr><td>Course Objectives:</td><td colspan="2">The course will enable the students to
1. Apply basic probability theorems and draw relevant inferences.
2. Analyze suitable probability model for given set of data
3. Demonstrate factorial design methods
4. Synthesize fractional and full factorial experimental design data</td></tr>
<tr><td>Content:</td><td></td><td>No of Hours</td></tr>
<tr><td></td><td>Using open-source software like libreoffice or any proprietary software perform following experiments:
1. Obtain probability values involving discrete probability distributions - Bernoulli, Binomial.
2. Obtain probability values involving continuous probability distributions - Exponential and Normal distributions.
3. Obtain values of Normal, t-distribution, Chi-square and F-statistic.
4. Obtain values of Mean, Variance and distribution function of Bernoulli and Binomial distribution.
5. Obtain values of Mean, Variance and distribution function of Exponential and Normal distributions.
6. Obtain values of central tendency of grouped and ungrouped data.
7. Obtain values of dispersion of grouped and ungrouped data.
8. Analyse experimental output using full factorial design.
9. Analyse experimental output using fractional factorial design.
10. Analyse a full case study in involving full factorial design or fractional factorial design.</td><td>60</td></tr>
<tr><td>Pedagogy:</td><td colspan="2">Inquiry based learning, Integrative, Reflective Learning, Constructive learning and Collaborative learning</td></tr>
<tr><td>References/ Readings:</td><td colspan="2">1. Tahvir Mustafy, Tauhid U Rahman, ‘Statistics & Data Analysis for Engineers and Scientists’, Springer, 2024, ISBN:9789819946600.
2. Jiju Antony, ‘Design of Experiments for Engineers & Scientists’, Elsevier, 2023, ISBN 978-044-315-1736
3. Douglas Montgomery, ‘Design and Analysis of Experiments’, Wiley India, Eighth Edition, 2013, 9788126540501
4. J. Ravichandran, Probability and Statistics for Engineers, Wiley India, 2010, ISBN: 9788126523504
5. R. Johnson, Probability and Statistics for engineers, Eighth Edition, Prentice Hall of India, New Delhi, 2015, ISBN 978-1-292-17601-7
6. J. Schmuller, Statistical Analysis with Excel for Dummies, 5th Edition,</td></tr>
</table>

	John Wiley & Sons, 2022.
Course Outcomes:	After taking this course, student will be able to: CO 1. Apply basic probability theorems and draw relevant inferences. CO 2. Analyze suitable probability model for given set of data CO 3. Demonstrate factorial design methods CO 4. Synthesize fractional and full factorial experimental design data

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